

TYPE OF REPORT: Semiannual

TIME PERIOD: July-Dec, 1995

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CONTRACT NUMBER: NAS5-31369

## ABSTRACT -- KEY POINTS

### BRDF/Albedo Product

The beta-3 version of the BRDF/albedo production code was delivered to SDST on schedule after major programming work. It passed all scheduled tests by performing i/o using EOS-HDF through the SDP and M-API toolkits, using the SMF error handling facility throughout, and adhering to SDST and ECS programming requirements. The code was delivered in form of two executables processing level 2G input data formats and producing level 3 BRDF/albedo tiles. Most ancillary data read capabilities and preliminary metadata handling are provided. Algorithm development was accompanied by progress in the science underlying the algorithm. The number of BRDF models to be used was reduced to six, including a new model that was developed for modeling forward scattering surfaces. The mathematical basis for the models used appeared in print, as did several conference contributions presenting the BRDF/albedo product to the science community. A journal-length paper describing the algorithm was prepared for submission to the Journal of Geophysical Research. A day-long expert briefing on the product was conducted on November 6 and concluded satisfactorily. Much progress was made on the mathematical tools required for assessing BRDF and albedo sensitivity to sampling patterns and noise.

### Land Cover/Land Cover Change

Coding for the Beta-3 was completed and delivered in this period. Algorithm development for the land cover and land cover change products continued with the pre-processing and analysis of multitemporal TM for Arizona and the Walnut Gulch region of Arizona. Testing and modification of the neural net and decision tree classifiers began on the 1-degree global NDVI dataset.

## TASK PROGRESS

### BRDF/Albedo Product

#### Model Development

Forward scattering land surfaces, mainly containing sub-resolution water components, were accommodated by developing a forward scattering BRDF model kernel based on a theory by Cox and Munk. The number of other BRDF kernels used for modeling of the product was reduced from 10 to 4 after analysis of MODIS/MISR sampling patterns. Including the empirical modified Walthall model, this leads to a total of six BRDF models that will be applied. This progress was reported in an update to

the ATBD that was made available on the EOS-MODIS ftp site and the World Wide Web.

### Model Validation

Applications of semiempirical BRDF models to field-measured and aircraft-measured data continued and aided in defining key model parameters. A manuscript on this work was prepared. Partial results were submitted to the Geophysical Journal as part of a paper describing the MODIS BRDF/albedo products as a whole.

In a collaboration with Robert d'Entremont of USAF Phillips Labs, the BRDF models slated for use in the MODIS BRDF/albedo product were preliminarily applied to cloud-cleared AVHRR data for the New England region. A potential for using BRDF-corrected reflectances in cloud detection was demonstrated.

In collaboration with Jean-Louis Roujean of Meteo France, new mathematical tools were developed for assessing the quality of individual angular sampling schemes with respect to BRDF retrieval. This will allow quality prediction of the BRDF/albedo product results given the variable angular sampling encountered by MODIS and MISR. A manuscript on the findings is in preparation.

### Beta-3 Algorithm Delivery

The largest piece of work in the reported period was the beta-3 delivery of the BRDF/albedo algorithm and the subsetting algorithm that builds the database required for this algorithm. Much of July through October were spent on this task, in close collaboration with SDST, the atmospheric correction team and the gridding specialists. All milestones set in a SDST/MODLAND meeting in late July were met. The code produced is beginning to resemble actual MODIS processing. All code uses the ECS-required SDP and SDST-required M-API toolkits to perform i/o and error handling through the smf facility. The data read is in L2G format as was produced by the code above BRDF/albedo in the processing hierarchy. Actual threading tests were completed successfully. Most ancillary data reads are available as is preliminary metadata handling.

The code consists of two executables, one preparing daily input data by subsetting it into a 16-day database, the second one producing the BRDF/albedo data product from this database. The L2G data format concept was found to be very valuable in this task. All HDF output and input formats were specified in their beta-3 form. Part of this delivery were software tools allowing flow and content testing and manipulation of HDF files, which were developed to go with the specific format of the BRDF/albedo product. Test data was produced both from field-measured BRDF data by Kimes and from the simulated SDST MODIS data set.

### Community Feedback on the Algorithm

At the IGARSS conference in July, three talks were given concerning the

BRDF/albedo product. One concerned the product as a whole, one the BRDF models used, and one validation by application to data measured in the Changchun Solar Simulation Laboratory in China. Response to these talks was positive.

On November 6, an expert briefing was conducted at Boston University. Invitees were John Martonchik, Chris Borel and Ranga Myneni from the MISR team, John Miller and David Meyer as non-EOS experts, and Jeff Privette from the MODIS atmospheric correction team. The purpose of this day-long meeting was to provide a thorough understanding of the algorithm and the science behind it to the panel members and to allow for critical feedback. Generally, the presentations were very well received by the panel members. Areas in need of further study were identified as being mainly related to the issue of angular sampling with respect to the MODIS and MISR orbits.

A journal paper was prepared describing the whole of the BRDF/albedo algorithm and its science. This paper is being submitted to a special issue of the Journal of Geophysical Research devoted to aerosol remote sensing and atmospheric correction. A paper appeared in that same journal describing the BRDF models to be used in detail.

Visitors connected to BRDF/albedo research were Jean-Louis Roujean from Meteo France and working for the POLDER project, and Raymond Soffer from York University, working on BRDF model validation.

## Land Cover/Land Cover Change

During this reporting period, we focused primarily on Beta-3 coding, development of the validation plan and algorithm development for land cover classification. We continued our work with advanced technology (AT) classifiers: neural nets, decision trees and adaptive classifiers including testing using the 1-degree AVHRR global dataset and at a number of sites. We attended and presented at the Land Cover Workshop at Flathead Lake on 6-8 September and Beta-3 code was delivered.

### Validation Plan

We began development of a draft validation plan for delivery in January 1996.

### Test Site Activities

Test site activity continued in Arizona, Walnut Gulch and BOREAS.

### Global 1-degree data

We began testing and modification of the neural net and decision tree classifiers for use with the 1-degree global NDVI dataset.

### Walnut Gulch/Arizona

We compiled a MODIS-like data set to examine feature-selection via decision trees with neural net classifiers. A time sequence of seven

selected TM datasets was co-rectified and spatially resampled to MODIS resolutions. Exploration of neural network and tree-based classifiers was temporarily halted because the quality of the ground truth information was limiting, and a new set of ground truth data was not obtained until the end of September. Additional analysis of the Walnut Gulch watershed began during this time period. These efforts will continue through the first quarter of 1996.

## BOREAS

We evaluated 10 flights of level-0 data from July 1994 of the Southern Study Area (SSA).

### Feature Selection

Feature selection work which was begun during the last reporting period is continuing.

### Neural Nets

Research on neural net classifiers continues especially its application to the global 1-degree NDVI land cover study. Pertinent issues include the use of limited training and validation (accuracy assessment) data, and geographical organization of the multitemporal data ie. stratification into latitude or hemispheric regions.

### Algorithm Coding

Beta coding of the land cover algorithm required a major effort during the period. Initial coding strategies were developed early in the reporting interval and the final beta code was delivered in 9/95. Planning and preparation for Version 1 of the algorithm were initiated during this time period.

## ANTICIPATED ACTIVITIES DURING THE NEXT QUARTER

### BRDF/Albedo Product

The main aim of work in the next quarter will be to systematically provide error limits on the BRDF/albedo product under conditions of sampling that varies with latitude and time of year as is typical for the MODIS and MISR sensors due to their orbits and instrument characteristics. Preparations for version 1 algorithm coding are expected to be stepped up. Validation and quality assurance plans will be developed.

### Land Cover/Land-cover Change Product

During the next quarter, we will expand test site activities to the 1-km NDVI dataset for the western hemisphere and especially Central America. Algorithm development and testing will include several neural nets, as well as decision trees. Work on Version 1 of the land cover code will continue.

In land cover change activities, we will begin testing of change vector analysis at specific sites to complement the multitemporal nature of the land cover activities.

#### PROBLEMS/CORRECTIVE ACTIONS

During this reporting period, we did not encounter any significant problems requiring corrective actions beyond the everyday problems that occur in research and algorithm development.

#### PUBLICATIONS

Normally we list here new publications and the current status of publications in progress. However, the administrative support person who performs this task resigned in November, and no replacement has been named. We will provide an updated list with the next semiannual report or before.